Summary of Cellular Design for a Liquid Argon Time Projection Chamber

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We begin by briefly introducing what a Liquid Argon Time Projection Chamber (LArTPC) is and discuss the physics case for it being the next generation neutrino ν_e appearance detector. Next, the challenges associated with the long wires necessary to build a 50-100kton LArTPC are introduced as follows:

1. The incomplete coverage of the entire tank by all three wire planes.
2. The safety, time and logistical issues of installing the wires in the tank at the correct tension.
3. The danger and consequences of wire breakage, particularly on cool-down.
4. Reconstructing events and associating signals in the different planes

Then, we introduce a possible solution (called a Cellular Design, see Fig. 1 & 2) to some of the problems caused by the long wires needed for the readout planes of a massive LArTPC. The Cellular Design could, but does not necessarily, address the first issue and may complicate the fifth, but it virtually eliminates the other three. We show how the Cellular Design mollifies those three issues.

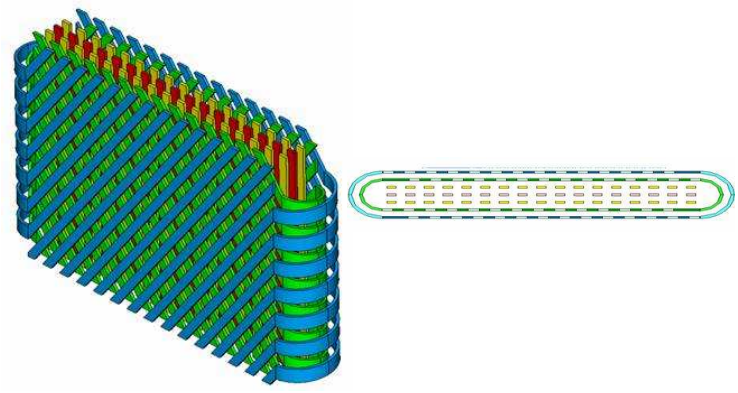

Figure 1: *Left:* 3-Dimensional view of one panel. *Right:* top view of one panel. The yellow layers are the vertical wires on each side; both the blue and green planes are angled.

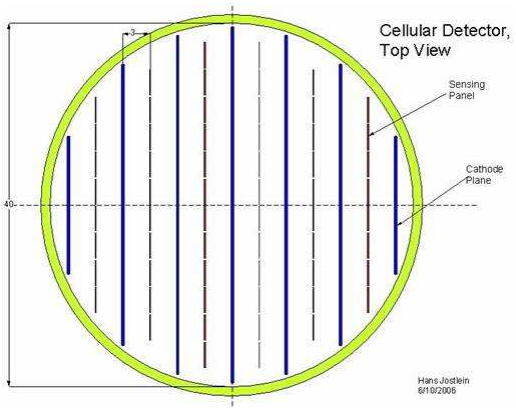

Figure 2: A top view of an entire Cellular Design detector with many panels inside.

Our discussion of how the Cellular Design addresses issues 2 and 3 is detailed. We include a projected time and cost analysis of building the panels. Further, an quantitative analysis of the precautions necessary to minimize wire breakage is provided, including some data which corroborate these findings.

The physical feasibility of the Cellular Design is then proven. The 'panels' are designed as ladder structures. A detailed design has been produced which addresses the two main engineering issues: first,eliminating strain on the panels and tank arising from the stress of the wire tension (both bending and buckling strains) and mass of the panels; second, maintaining exact wire alignment. A thorough analysis of the stresses is provided, conclusively showing that the panels can physically withstand the tension of the wires and will be of reasonable weight. Further, we show that wire alignment can easily be managed using the Cellular Design.

Next we exhaustively discuss and analyze the implications for the reconstruction the 'panel' design introduces. Since the wires of the angled planes wrap around both sides of the panel, one cannot tell on which side of the panel a track passed from the angled wire data alone. While the vertical wires resolve this ambiguity, the vertical position of a track is only known modulo the vertical wrap spacing. Through a simulation of the cellular design readout using GEANT3 to of cosmic muon tracks we have shown that it is in fact fairly easy to reconstruct the muon topologies from simulated wire readouts. Example of the simulation is shown and analyzed.

However, the vertical and transverse positions are still somewhat ambiguous. We then discuss how this ambiguity can be greatly lessened (if not eliminated) by using light sensing panels. Charged particles in liquid argon produce a substantial amount of far-ultraviolet scintillation light in liquid argon. The specifications of the light sensing panels are discussed. A study of the relationship between argon purity and light transmittance is conducted, concluding that light detection should be a feasible option. Further, we will present data from preliminary studies of such panels, comparing coated and doped plastic as a converter from UV.

At the end, we conclude that the Cellular Design for a LArTPC provides a solution to some of the construction, installation and coverage problems associated with the long wires in our previous massive LArTPC designs. We acknowledge that it presents new challenges for reconstruction. We find the addition of installing light-collecting devices inside the Cellular Design panels very attractive